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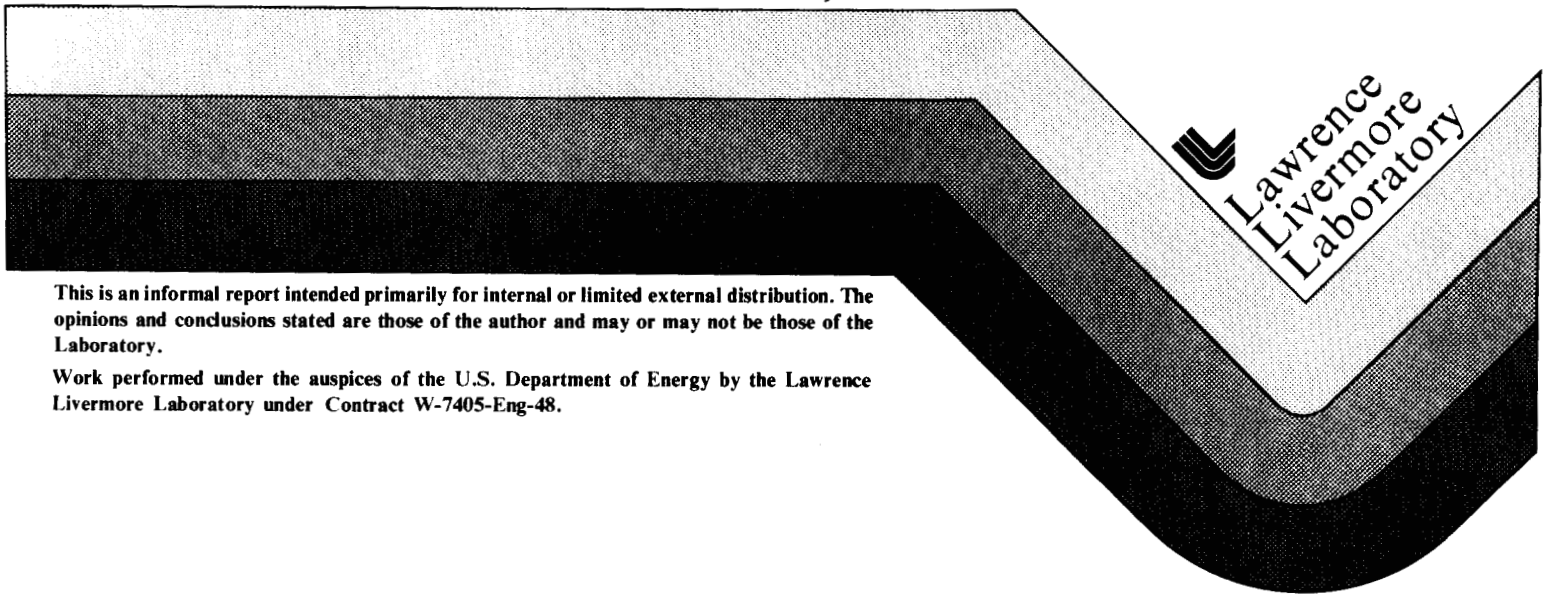

CALIFORNIA ENERGY FLOW IN 1979

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ABSTRACT

Energy use in California during 1979 differed significantly from 1978. Overall use of natural gas in the state increased substantially (14.3%) due principally to greater use for electrical power production. 47% more gas was used for electrical power generation in 1979 than in 1978 and 21% more than in 1977. Use of fuel oil for electrical generation remained at the 1978 level but below the high 1977 level which reflected substitution of oil for hydroelectrical power during the 1976-7 drought. Together oil and gas accounted for 80% of the fuels used to generate electricity.

Crude oil imports principally from Indonesia fell substantially; however use of Alaskan North Slope oil increased so that the net increase in crude oil use was up about 4%. The transportation end use sector consumed about as much as in 1978 despite shortages in early 1979 associated with the Iranian revolution. While gasoline sales fell slightly, sales of high sulfur residual oils (Bunker C) increased markedly. Transportation represents 38% of total energy consumption in California.

The industrial climate remained robust as judged by energy consumption - up 12%. Nonetheless fertilizer production in the state is falling due to higher natural gas prices. Firm customers in the residential, commercial and firm industrial sectors registered modest increases in energy use reflecting in part the population increase.

INTRODUCTION

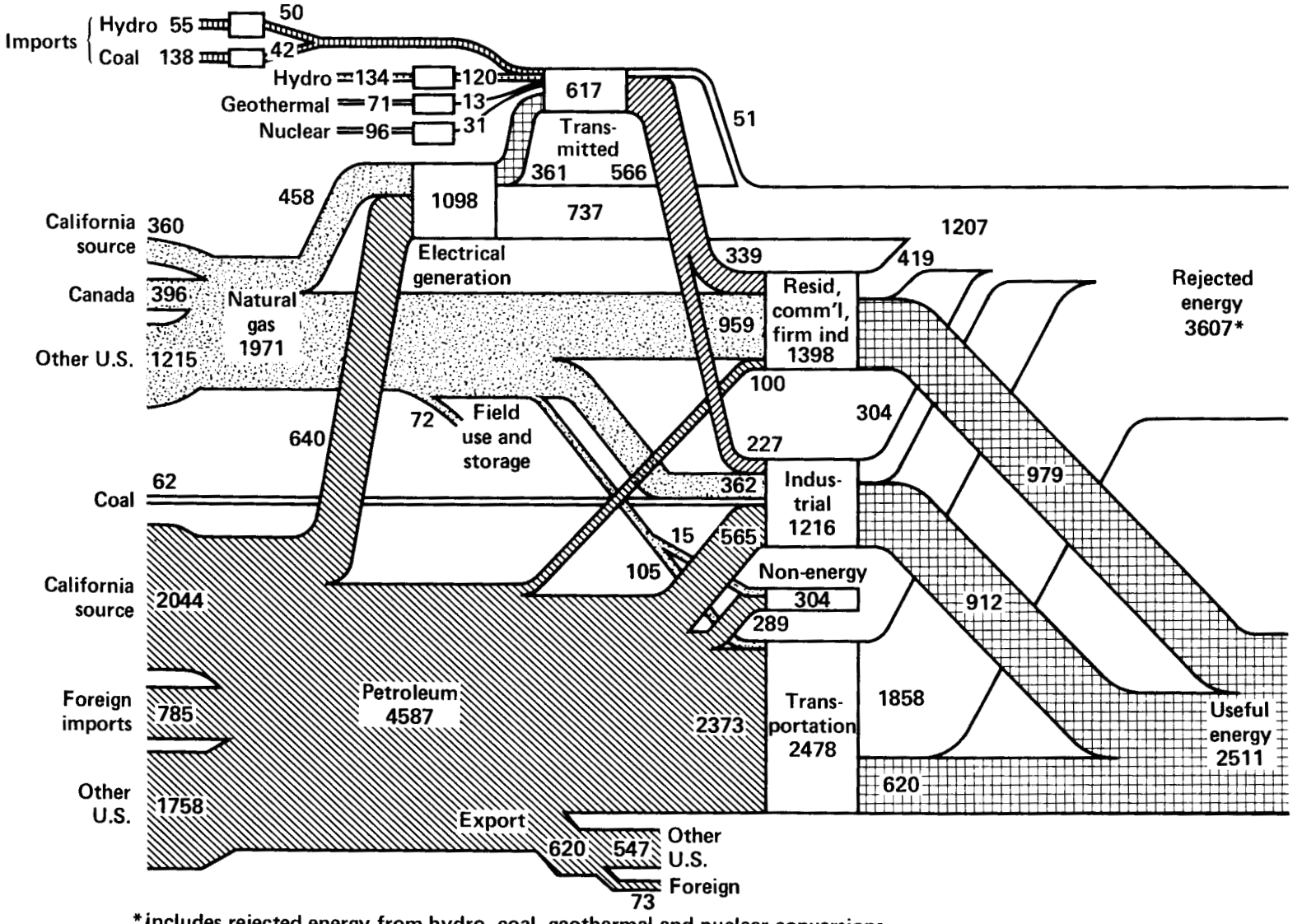
Energy flow diagrams for California prepared for 1974, 1976, 1977 and 1978 by members of Energy and Resource Planning Group at the Lawrence Livermore National Laboratory have proven to be useful tools in assessing supply and end use of energy in the state.[1,2,3,4] To assure uniformity with other years as far as possible the same sources and conventions were used for the 1979 California energy flow diagram presented here. (Figure 1).

To this end we have also used the same conversion efficiences as used in construction of past energy flow diagrams. For conversions to electrical power they are assumed to be 90% (hydro-electricity), 30% (coal), 18% (geothermal), 33% (oil and gas) and 32% (nuclear). Assumed efficiency for transporation is 25% which is the approximate efficiency of the internal combustion engine. As in past years 70% and 75% were arbitrarily assumed in residential/commercial and industrial end use sectors respectively. See Ref. 2 for a more detailed description of how major end use sector efficiencies were determined.

Source of Data

Tables 1 and 2 list the supply and end use sources. Most of the data were compiled from the California Energy Commission (CEC) Quarterly Fuel and Energy Summaries. The 65th Annual Report of the State Oil and Gas Supervisor provided crude oil and natural gas production figures (352 million barrels of oil and 343 BCF) including production from federal offshore fields (11 million barrels and 5.4 BCF).

CALIFORNIA ENERGY FLOW – 1979
TOTAL ENERGY CONSUMPTION 6500 X 10^{12} Btu



*includes rejected energy from hydro, coal, geothermal and nuclear conversions.

Data: California Energy Commission; California Division of Oil & Gas, DOE/EIA.

Figure 1

Some of the DOE Energy Data Reports used in past years were unavailable at time of preparation. However, most of the information they provided were available in the CEC Quarterly Fuel and Energy Summaries. Exceptions were data on the use of LPG, kerosene, distillate and residual fuel oil in the residential/commercial sector. As the combined use in California is relatively small it was estimated at same level as 1978. Similarly, in the transportation end use sector the total diesel used by the military and the railroads was estimated at last year's level of approximately 65 x 10^{12}Btu.

Table 1
Data Sources for California Energy Supply

Production	
Crude Oil including Federal Offshore and Lease Condensate	Ref. (5)
Associated and Nonassociated Natural Gas	Ref. (5)
Electrical Generation (hydro, coal, nuclear, oil, gas, geothermal)	Ref. (6) Tables A,B and C
Imports	
Natural Gas Foreign and Domestic	Ref. (6) Table A
Crude Oil Foreign and Domestic	Ref. (6) Table O
Oil Products Foreign and Domestic	Ref. (6) Table S
Coal	Ref. (7) Table 4
Electrical Power	Ref. (6) Table A
Exports	
Oil Products Foreign and Domestic	Ref. (6) Table T

Table 2

Data Sources for California End Uses

Net Storage and Field Use	
Natural Gas	Ref (6) Tables A and L
Transportation	
Crude Oil	
Refinery output of gasoline aviation fuel and jet fuels	Ref. (6) Table Q
Taxable diesel fuel (i.e. for public highways)	Ref (8) Table J-3
Vessel Bunkering	Ref (9) p. 11
Exports of gasoline, jet fuel and Bunker C	Ref. (9) Table S
Rail diesel	Est. (see text)
Military Use	
Natural Gas	
Lost or unaccounted for (transmission and pipeline) from gas utilities	Ref. (6) Table J
Non-Energy Applications	
Crude Oil and LPG	
Asphalt	Ref. (10) Table 2
Petrochemical feedstock	Ref. (6) Table Q
Waxes, lubricating oils medicinal uses, cleaning	1/3 of asphalt and road oil totals. see Ref. (2)
Natural Gas	
Fertilizer	Ref. (4) and (11)
Residential and Small Commerical	
Natural Gas	Ref. (6) Table J
Crude Oil and other oils LPG heating	Est. (see text)

Table 2 - continued

Fuel oil and kerosene	Est.
Residual and distillate oil (heating)	Est.
Miscellaneous "off highway" diesel	Est.
Electricity	Ref. (6) Table C
Industrial, Government, Agriculture etc.	
Natural Gas	by difference
Coal	Ref. (7) Table 4
Electricity	Ref. (6) Table C
Crude Oil	by difference

AGGREGATION OF DATA

As in past years the flow diagram combines residential, commercial and firm industrial customers, all with highest priority among utility customers. Interruptible industrial customers make up another large end use sector. The category called "Non-energy" use includes petrochemicals, asphalt, waxes, fertilizer etc.; these uses produce neither heat nor mechanical work.

Out-of-state hydro-electric power is from the Pacific Northwest (Bonneville Power Administration) and the Southwest (principally Hoover and Davis Dams on the Colorado River). Out-of-state coal fired plants are at Four Corner, Farmington, New Mexico; Navaho Plant at Page, Arizona; and the Mohave Plant, Nevada. The transmitted electrical power from imported hydro sources was derived from the net exchange in interstate transfers; power from out-of-state coal-fired plants is recorded separately by the CEC.

Conversion from fuel quantities to Btu was made using U.S. Bureau of Mines factors given in the Appendix.

COMPARISON WITH 1978 AND PAST YEARS

Table 3 (tabulated in part from Fig. 1 and Fig. 2) provides a quick comparison of 1979 and 1978 energy consumption. 1979 like 1978 was somewhat warmer than the "normal" (Table 4). Natural gas use is up 14.3% as a result of increased supply from all sources. Electric utilities (lowest priority user-- Priority 5) burned 47% more natural gas to produce electricity than in 1978.

Table 3

Comparison of Annual Energy Use in California

(in 10^{12} Btu)

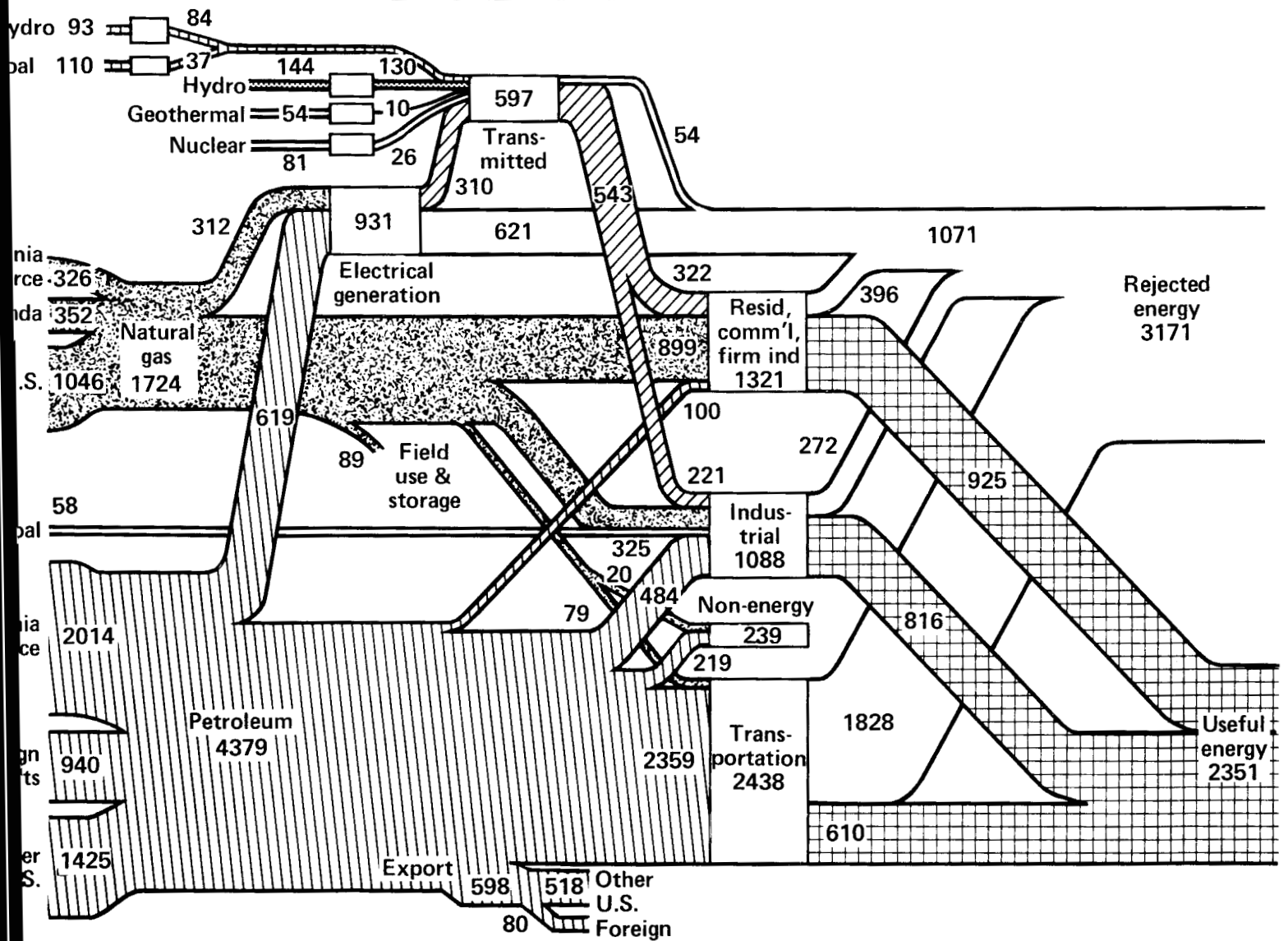
	1976	1977	1978	1979	Change 1978 vs. 1979
Natural Gas	1844	1831	1724	1971	+14.3%
Crude Oil	3886	4516	4379	4587	+ 4.7%
California Source	1921	2027	2014	2044	+ 1.5%
Foreign Imports	1606	1875	940	785	-16.5%
Other U.S.	359	614	1425	1758	+23.4%
Domestic/Foreign Exports	630	796	598	620	3.7%
Net Use	3256	3720	3781	3967	+ 4.0%
Electricity					
Imports*	158	100	121	92	-24.0%
Imports**	267	208	203	193	- 4.9%
Hydroelectric	94	54	144	134	- 6.9%
Geothermal and Other	79	63	54	71	+31.5%
Nuclear	51	84	81	96	+18.5%
Gas	358	380	312	458	+46.8%
Oil	619	806	619	640	+3.4%
Total Fuel	1413	1595	1413	1592	+12.7%
Total Transmitted Energy	577	574	597	617	+ 3.4%
Residential/commercial/firm industrial	1406	1253	1321	1398	+ 5.8%
Industrial	1162	1248	1088	1216	+11.8%
Nonenergy	222	221	239	304	+27.2%
Transportation	2004	2199	2438	2478	+ 1.6%

* As imported Mw·h (not energy-fuel equivalents)

** As hydroelectric power or coal before conversion to electricity

ORNIA ENERGY FLOW – 1978

ENERGY CONSUMPTION 6050 X 10^{12} Btu



Data: California Energy Commission; California Division of Oil and Gas, DOE/EIA

Figure 2

Table 4

WEATHER COMPARISON

1958-1977

ANNUAL HEATING DEGREE DAYS*

	San Francisco Federal Office Building	Los Angeles Civic Center	San Diego Lindbergh Field
1958	2332	849	805
1967	2978	1040	1380
1968	2942	850	1052
1969	3066	1032	1145
1970	3006	941	1137
1971	3468	1424	1657
1972	3240	918	1166
1973	3161	1066	1137
1974	3182	1084	1123
1975	3313	1548	1416
1976	2665	1128	793
1977	2888	911	747
1978	2599	1208	736
1979	2545	1160	902
Normal 1941-70	3080	1245	1507

*Source: Local Climatological Data, for San Francisco, Los Angeles, and San Diego.

National Oceanic and Atmospheric Administration
National Climatic Center
Asheville, N.C.

Increased natural gas supply resulted from enactment of the Natural Gas Policy Act of 1978 which did away with the two-tier price structure between interstate and intrastate gas. This Act also allows natural gas prices to rise gradually until 1985 when price controls on new supplies (discovered after 1977) will be completely lifted. The higher prices have brought more gas out of formerly strictly intrastate markets like Texas.

While the NGPA of 1978 encourages increased gas production by higher prices, the 1978 Fuel Use Act, conceived when gas supply was thought to be dwindling, prohibits major fuel-burning installations (over 2.5 mcf/day) from burning gas and states that all electric power plants have to be off gas by 1990. This seeming contradiction has prompted the gas industry to seek repeal of several portions of the 1978 Fuel Use Act.[12]

Alaskan North Slope crude oil supply has increased by 23.4%. Foreign imports, primarily from Indonesia, which is the largest single source at approximately 93 million barrels, have decreased by 17%. Since Alaskan crude oil is lower gravity and higher in sulfur content than foreign oil, Califonia refinery output of high sulfur residual oil increased and produced a surplus of this product. Refiners reduced the price of high sulfur residual oil which attracted ships to refuel in California. Hence, Bunker C fuel consumption increased 24% in 1979 over 1978.

The 2.2 GWe Diablo Canyon Nuclear power plant, which was virtually complete in 1979, awaited licensing. When operational, it is expected to displace 20 million barrels of oil or oil equivalent annually (116 x 10^{12} Btu).

Residential/commercial and firm industrial usage increased 6% over 1978. Natural gas input to this sector increased 7% reflecting greater availability of natural gas and perhaps a slight relapse from what has been viewed as the conservation ethic of 1977 and 1978. The conservation effect which was driven largely by the 1977 drought is likely to be revived as a result of increased rates in 1980.

Industrial sector end use increased 12% in contrast to 1978's 13% drop. Natural gas input was up 11%, again reflecting increased natural gas supplies available to interruptible industrial customers. Use of petroleum increased 17% whereas coal and electrical input to the industrial sector were approximately the same as last year.

Table 5

Transportation End Use

	x 10^{12} BTU	
	1978	1979
Net Gasoline	1500	1439
Net Aviation Fuel	357	350
Taxable diesel fuel-Public Highway	149	161
Rail diesel	35	35
Net Bunkering	288	358
Military	30	30
Total	2359	2373

During early 1979 there was a gasoline and diesel fuel shortage in California and the rest of the nation. It was due in the main to a reduction in crude oil supplies because of the Iranian Revolution. Complex price regulation of gasoline contributed to the adoption of an allocation system by major refiners which in turn resulted in reduced service station hours and pump shut-downs during early 1979. The marketing procedure created gas lines in many areas of the state. A change in price regulation by the DOE allowed gasoline prices to escalate which reduced demand, and gasoline lines were gone by the end of 1979.[14]

COMPARISON WITH U.S. ENERGY USE

California's energy mix and consumption patterns continue to be in marked contrast to the nation's. A comparison of Figure 1 and 3 from Rf 15 shows the greater role oil and gas have in energy production in California than in the U.S. In 1979 oil and gas use rose almost 8% in California. Coal continues to play a very minor role in the industrial sectors in California. There are no coal burning electrical power plants within the confines of the state. The importance of oil and gas is a reflection on the indigenous industry and the availability of supplemental supplies from Western states. The principal use of oil in California is in the transportation sector. For this reason light oils imported from Indonesia are used in preference to an exclusively California/Alaska mix. The latter have a relatively smaller gasoline/light product output from conventional refinery distillation operations than do lighter oils with API gravities greater than $^{o}30$. The higher sulfur content of most heavy oils also mitigates against their use in California's polluted air basins. Fuel oil is used sparingly in California for residential and commercial space heating. In the U.S. as a whole about 18% of all oil consumed goes to the residential/commercial sector.

U.S. ENERGY FLOW – 1979

(NET PRIMARY RESOURCE CONSUMPTION 77.8 QUADS)

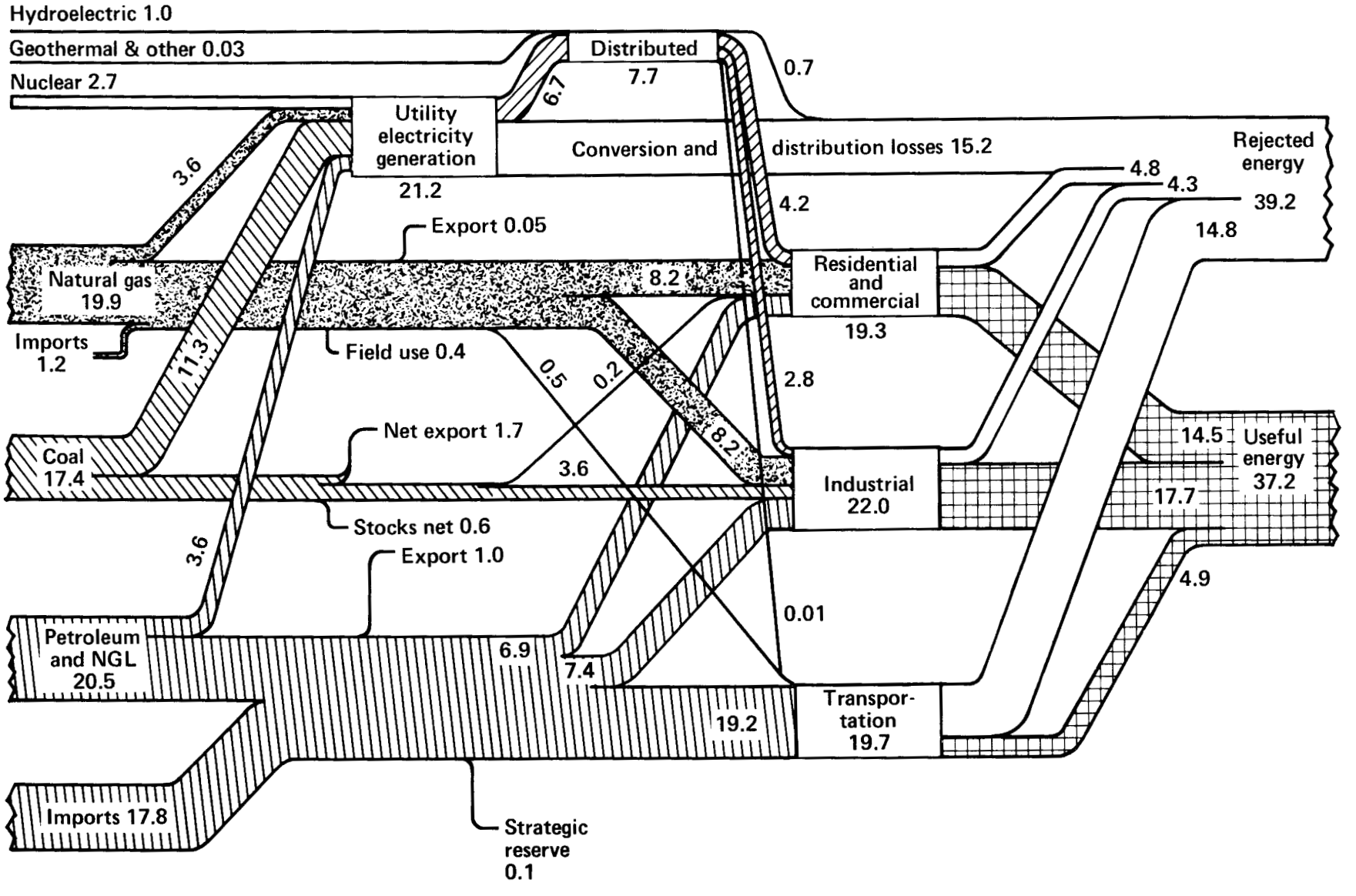


Figure 3

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APPENDIX: CONVERSION UNITS

Energy Source	Conversion factor, 10^6 Btu
Electricity	3.415 per MW.h
Coal	22.6 per short ton
Natural Gas	1.05 per MCF
LPG	4.01 per barrel
Crude Oil	5.80 per barrel
Fuel Oil	
Residual	6.287 per barrel
Distillate, including diesel	5.825 per barrel
Gasoline and Aviation Fuel	5.248 per barrel
Kerosene	5.67 per barrel
Asphalt	6.636 per barrel
Road Oil	6.626 per barrel
Synthetic Rubber and Miscellaneous	
LPG Products	4.01 per barrel

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